AMPUTATIONS AND PROSTHESES IN PRIMITIVE CULTURES [a]

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INTRODUCTION

The study of man's medical history is difficult, since it is accomplished by correlating rare written records, archaeological findings, and ethnological information.

To accurately deduce diagnoses and treatment from art is also difficult. The work of art being examined may be an abstraction or stylization. We can make accurate deductions only from those art works that clearly demonstrate that the artist intended to portray the physical condition of the patient accurately. It is far too easy to read things into a work of art that the artist may not have intended to portray. It is easy to be misled by attributing modern thinking to the "ancients." Most primitive treatment was based on magical concepts and not on empirical therapeutics. For this reason, clues to the thinking and customs of the ancients can often be gleaned from the facts gathered about more modern "primitive" civilizations.

Pottery can now be dated accurately by thermoluminescence and magnetic field studies. None of the pieces of pottery illustrated had been dated this way, since these studies are destructive. Approximate dates can be obtained by radiocarbon and art-style methods, which is how the illustrated pots were dated. The names of the cultures used are those which are given by archaeologists for identification purposes and ease of communication. In this paper, rough estimates will be given to indicate the general time span when each art style was current. Roughly speaking, before 1500 C.E. will be referred to as "ancient." As there is controversy among authorities in archaeology, only one interpretation is given.[b]

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[a] This work, in somewhat different form, will appear as part of a chapter in the forthcoming book, "The Rehabilitation of the Amputee," by Lawrence W. Friedmann, M.D., Charles C Thomas, publisher.

[b] In this work, the term "ancients" refers to individuals who lived prior to 1500 C.E., while the term "later primitives" refers to those living after that time. "C.E." is the abbreviation for "Christian Era" and "B.C.E." is "Before Christian Era."

Pottery is often found broken and must be reconstructed. Any figurine in which a limb is missing must be suspected of having had the limb broken or weathered off.

REASONS FOR AMPUTATION

Congenital

The Anciens

In ancient Mexico, most art served religious purposes and thus was symbolic and not realistic. This makes it useless for paleopathologists, though priceless for art lovers. It is rare for theological art to show malformations.

Out of the many thousands of pieces of pre-Columbian pottery found to date, possibly fewer than one hundred show definite or probable amputation. Of these, perhaps a dozen show congenital limb absence or deformity. All are North American.

The Tlatilco culture was in flower from 1500 B.C.E. to 200 C.E. in the Valley of Mexico. Their figurines often have large legs and very short arms. It is possible that this was intended to demonstrate phocomelia, but this is probably a stylistic artifact.

Figure 1 is from the Zacatenco Mexican culture and illustrates clearly that even a relatively crude figure made between 1500 B.C.E. and the

FIGURE 1.—Figurine, Zacatenco, Mexico, 1500 B.C.E.–200 C.E., Peabody Museum, Harvard University, Cambridge, Mass.

FIGURE 2.—Figurine, style unknown, Mexico, date unnown, author's private collection.

first century C.E. can demonstrate congenital anomalies. Here we see three extremities, crudely done but complete. On one side, one notes the complete absence of an upper extremity. Turning the figurine on its side convinces one that the artist intended to show the absence of one arm and its shoulder, since the piece was fired with this defect.

Figure 2 is from an unidentified culture in Mexico and shows short lower extremities and large shoulders, with small upper arms and hands in a position characteristic of phocomelia. The shape is very unusual, so we doubt that this is a stylistic artifact. Primitive artists generally spent considerable effort in emphasizing the points of major interest in a work of art, and de-emphasized less significant details. Almost all of the work in this figure is crude. The legs, although showing toes, are primitive. The most finely worked parts of the figure are the upper extremities. It is for this reason that we believe the artist in this case attempted to demonstrate phocomelia.

Figure 3, in the so-called Chinesco style that flourished from the first to the third century, C.E., in northwestern Mexico, shows a figure with normal lower extremities but no arms. In addition to the absence of arms, the shoulders slope downward sharply, as they would in a congenital amelic. In order to properly evaluate whether the artist intended to portray amelia of the upper extremities, one needs to examine other artifacts from the same culture and art style. Such examination discloses that the shoulders are portrayed realistically and that the arms, while

FIGURE 3.—Figurine, Chinesco, Mexico, 0–300 C.E., author's private collection.

FIGURE 4.—Figurine, Chinesco, Mexico, 0–300 C.E., author's private collection.

small, are definitely illustrated. This convinces us that Figure 3 is indeed an artistic representation of amelia of the upper extremities.

Figure 4 is also in the Chinesco style. The right lower extremity ends above the knee, while the left lower extremity shows the knee clearly. The arms are characteristic of the Chinesco style, one arm being longer than the other. The difference between the two lower extremities appears to be purposeful. This is the only example of possible above-knee amputation known in Chinesco art.

Mayan figures from Guatemala and Mexico occasionally show extremities that end in nubbins, which may have been intended to show congenital abnormalities. This culture existed from 150 to 1200 C.E.

The Mexican Huastecs had a long cultural history, probably shared in the early stages with the Maya. They are known to have existed from at least 1700 B.C.E. to the Spanish conquest—a span of over 3000 years. Figure 5 is the only Huastec figure known to show a congenital amputation.

FIGURE 5.—Figurine, Huastec, preclassic, Mexico, 1500–0 B.C.E., American Museum of Natural History, New York, N.Y.

The Aztecs, whose culture existed from 900 to 1519 C.E. in the Valley of Mexico, paid special attention to congenital deformities and believed that their god Xolotl produced monstrosities and deformities. In contrast to most Indians and primitives, the congenitally deformed were not destroyed at birth. This may be the reason why pottery showing amputation from Mexico illustrates only congenital absence of limbs and limb deformities, while pottery from Peru and elsewhere illustrates only acquired amputations. Montezuma II (61) kept people with congenital

amputations and deformities in a special compound adjacent to the Royal Zoo and Botanical Gardens. The immediate destruction of congenitally deformed infants in most other primitive cultures is indicative of the great social stigma which accrued to the parents of these children, since a child's deformity was, and is, regarded as punishment for parental sin.

Haj (31) states that in the six centuries after the birth of Mohammed, at the height of Moslem power, congenital amputations were known but were relatively uncommon. He states that it was the custom for a man to take his first cousin as his most desirable wife and this familial intermarriage probably increased the incidence of congenital anomalies.

Later Primitives

Most primitive people destroy their deformed infants. Disease among primitives is felt by them to be predominantly due to the action of supernatural forces. Disease is thus involved with guilt, especially for hereditary conditions; this has carried over to some extent to our time. Primitive medicine is primarily magical and religious, even though it may utilize a few empiric elements. Modern medicine is predominantly based upon empirical evidence, but still contains a few magical elements.

Hrdlicka (34) quotes the case of a Pima American Indian woman who gave birth to an infant with upper-extremity amelia. The child was not allowed to live. In describing congenital deformities in American Indians, he agrees that most Indians encourage children with anomalies to perish. He states that Dr. J. Powlas gave information about one 12-year-old girl from the Oneida tribe of Wisconsin who survived, who had congenital shortening of one limb. Among the Piegan American Indians he quotes Dr. George S. Martin, who says that he found an 8-year-old boy who had been born with only rudimentary fingers on both hands who was also permitted to survive.

Congenital anomalies have occurred from time immemorial. Figure 6 illustrates a bilateral upper-extremity amelic in a series of drawings from 1654, performing many activities of daily life. This woman was Swedish. The figure is a copy of a German newspaper clipping reproducing drawings of her activities. The center photograph shows the patient firing a pistol with her feet, while the surrounding drawings show her handling her infant, nursing, bathing, and dressing the child, as well as knitting, sewing, crocheting, playing cards, etc. All of these activities are shown being performed with the patient's feet. This principle is unfortunately neglected when training many of our child and adult bilateral amelics today. This type of specialized foot training, which is emphasized by Marquardt (Fig. 6), should be reemphasized in all of our clinics treating this type of patient.

FIGURE 6.—Newspaper drawings, Germany, of Swedish amelic, 1654, courtesy of Prof. Dr. Med. Ernst Marquardt, University of Heidelberg, Germany.

Disease

The etiology of acquired amputation may be varied. It may be due to trauma, disease, or surgery. If the amputation is surgical, the surgery may

have been performed for curative, ritualistic, vocational, juridical, or esthetic purposes. Without records, we must try to deduce the reason for amputation. The argument over causation of Peruvian amputation has now lasted over 100 years. Study of figures showing mutilation of the nose, lips, and extremities (Fig. 7 and 8) was first commenced *systematically* in 1895 when Samuel Mathewson-Scott (48) took from Peru to the United States a collection of pottery of the Valley of Chira in Peru, some of which represented the mutilation described above. That is when the discussion commenced on whether the deformities were the result of disease or surgical procedures. Pardal (55) said that Virchow and Ashmead (8) felt that some of the pieces (Fig. 9) represented leprosy and some of the others a parasitic skin disease. However, Ashmead vacillated between 1897 and 1901 (7, 8, 9, 10). Virchow (55) said at the Leprosy Congress of 1897 that bony syphilitic lesions in American natives in the time before Columbus were not observed. Polakowsky (59) and Lamb (40) said that there was no evidence in the Spanish-American literature of leprosy among the Indians prior to the arrival of Columbus. Carrasquilla (55, p. 223) of Bogota, Colombia, had attributed the mutilation shown on many of the figures to punishment of criminals. At the Leprosy Congress of 1897, the problem remained without solution, as it

FIGURE 7.—Effigy jar, Moche III, Peru, Trujillo, 0–200 C.E., Museum of the American Indian—Heye Foundation, New York, N.Y.

FIGURE 8.—Bottle, Moche III, Peru, Chicama Valley, 0–200 C.E., Museum of the American Indian—Heye Foundation, New York, N.Y.

FIGURE 9.—Effigy jar, Moche III, Peru, North Coast, 0–200 C.E., said to represent head of syphilitic man. (Photograph courtesy of Museum of the American Indian—Heye Foundation, New York, N.Y.)

remains today. The list of authors taking various sides in the argument grows longer every year.

Haj states that medical amputations were rare in the Middle East since any attempt at cure of a disease implied that the patient was trying to avoid what God had predestined. None wanted to have a medical amputation because it identified him with criminals. He cites examples of people who lost limbs due to frostbite who carried certificates with them stating that the cause of their amputation was medical and not penal. They showed these certificates as proof of their good character.

Wells (77) discussed whether leprosy occurred in the Americas prior to the arrival of Columbus. He said that evidence had not been found for it in Peruvian mummies nor in excavated bones. Wells feels that we can reject the theory of its existence, which is based solely on information of facial deformities found on the water jars of Peru, Bolivia, and Ecuador. He stated that these jars show destruction of the lips, nose, and sometimes with loss or deformity of the feet. He agrees that these are probably not leprosy as claimed by Lehmann-Niestche in Lastres (43), but that it is American leishmaniasis (which is called by a number of native names, the most common of which are "uta" and "espundia") as claimed by Tamayo in Lastres. American leishmaniasis is related to kala-azar found in Burma and Africa. Wells pointed out that there is a vase of this type in which a person is shown cutting off the lips of another person with a broad-bladed knife or tumis. He pointed out that many of the Moche pots show amputation of the limbs on the pottery, but

amputations are found rarely in the mummies (66). Lamb doubted that tuberculosis of the skin existed causing the mutiliations demonstrated on the pottery. He regarded the amputations as resulting from punishment or surgical operations.

Magical—Surgical

The Ancients

Gods are represented in many ways, but representing them as amputees is most rare. One pot is extant that shows Aia Paec, the primary god of the Peruvians (42), as a feline with an arm amputated above the elbow (Fig. 10). Coury (20) points out that the Aztec god of creation and vengeance, Tezcatlitoca, had his right foot amputated.

Acquired amputation of the lower extremities is much more prevalent in the Western world today than is that of the upper extremities, since vascular disease is much more common than trauma. Pre-Columbian art showing amputation reflects this difference, but perhaps for different reasons. The earliest and most common amputations among primitives were finger removals for ritual purposes. The earliest representations are described in Wells: "On the walls of a dozen of more caves in France and Spain, there are negative imprints, i.e., the paint was applied around a mutilated left hand. In one cave, that of Gargas (Haute-Garonne), many of these hands show mutilation by the loss of some or all of the fingers. Almost all possible combinations occur, including part or total loss of a thumb" (77, p. 32). These drawings have been dated to 5000 B.C.E. From more modern practices among various tribes, it is assumed

FIGURE 10.—Bottle, Moche III, Peru, North Coast, 0–200 C.E., author's private collection.

that these Gargas paintings represent mutilation done purposely for ritual or religious reasons. The loss of the thumb almost entirely eliminates effective function of the hand. Wells suggests that the hand mutilation may have been caused by disease. Some claim that the hands are small and may be those of women and children affected by frostbite. Wells points out that the paintings are from Spain, which was then warm, and in nearby cooler French caves, amputated fingers were not found on similar drawings. Wells considers that Raynaud's disease or leprosy may have been causative.

According to Major (47) such imprints of hands and amputated fingers have been found in North America in Mexico, California, and Arizona; in South Ameria in Peru; in Africa; in Australia; in the Middle East in Israel, Egypt, Arabia, Babylonia, and Phoenicia; and in India (16, 22). It persists at the present time among certain aboriginal tribes. In many instances, it is performed to appease a god, to drive out demons, to signify mourning, or to indicate caste.

Disselhoff (24) has discovered a Mayan pot of human form, in the Cave of Santa Cruz, Guatemala, containing human amputated digits with the blades of obsidian, which were used to amputate them. He points out that the digits were considered as having a special magical power, as were the digits ornamenting the prehistoric caves in France.

Later Primitives

Haj says that magical amputations were not performed in the Arabic Middle East.

In order to obtain a better perspective on the place of amputation in the lives of people who lived before Columbus landed on our shores, it is helpful to consider the thinking, customs, and attitudes of primitive peoples around the world to force us to take our thoughts out of accustomed patterns, so as to better comprehend their total lives.

Ackerknecht (1, 2) mentions that ritual and punitive mutilations were an almost universal practice in primitive societies. Lagerkrantz (39) in 1935 pointed out numerous instances of finger amputation in 14 tribes in Africa, Madagascar, and Indonesia. He states that these were generally ritual amputations to get rid of evil spirits and to produce potions and amulets to prevent evil. The portions cut from the body were frequently roasted or burned and then used as charms, either as ashes or as roasted parts. Frequently tattoos were made by incising the skin and rubbing the ashes into the open wound. The ashes were often mixed with other substances such as flour and parts of animals. On occasion a combination of materials, including ashes from the amputated finger, were eaten without touching the mixture with the hands. A bag containing the ashes or body parts was worn as a charm or amulet around the neck or loins. Amputation of the finger or hand and other forms of mutilation

were also the punishment for persistent thieves, adulterers, and arsonists. Both the fingers and toes were amputated and the blood was sprinkled to bring good luck or to avoid evil spirits. The body parts could be taken from living captives or from the dead. This was often the basis of cannibalism (39), which was rarely done for food.

Söderström (65) in 1938 named 14 tribes performing amputation and multilation of fingers in India, Australia, and Oceania. The amputations were performed for magical, punitive, or medical purposes. Finger amputation for punishment was done by 11 African tribes and 11 South Seas tribes.

The whole hand was amputated in Uganda, according to Roscoe (60), and in Bahr-Lel-Ghazal, Sudan, according to Anderson (6). In other cultures, amputation is dreaded more than death, since it affects the "spirit" life after death. Amputation is thus used as punishment for crime in some of these cultures. According to Vogel (75), Dr. Bourke exhibited an Apache necklace made of human fingers (13).

Maximilian of Wied in 1834 (49) reported that a Gros Ventre American Indian woman had cut off one joint of her little finger as a sign of mourning, and had her bleeding stump wrapped in a handful of wormwood leaves to stop the bleeding.

Medical (Curative—Corrective)

The Ancients

Gillis (27) states that Hippocrates mentioned that the ancients performed amputations as life-saving procedures and to remove useless body parts to reduce invalidism.

Celsus (17) apparently lived some time during the reign of Emperor Tiberius and some people place his birth about 25 B.C.E. Celsus is felt by many people to be a translator of previous Greek medical information and not a physician. He recommended that when gangrene developed between the fingernails and the axilla or the toenails and the groin, if medications failed to cure the gangrene, then the limb should be amputated. He pointed out that amputation had to be performed because it was the only recourse in attempting to save the patient's life. For either the upper or lower limb, if there was a severe fracture with fragments separated widely from each other, Celsus recommended amputation as being generally necessary. He stated that this was more commonly needed in the lower than in the upper extremity.

Brothwell and Møller-Christensen (15) describe the skeletal remains of an amputated radius and ulna from Sedment, Egypt, dated to the 9th dynasty. The distal end of the forearm shows both bones rounded, with what appears to be healing with the development of osteophytes and a bone bridge between the radius and ulna. There is scattered pitting and irregularity, especially on the shaft of the radius. This appears to have

been caused by osteomyelitis. There does not seem to be much osteoporosis.

While this amputation stump is of great interest, some of the conclusions of Brothwell and Møller-Christensen appear to need more proof. They state that loss of a limb may have resulted from one of three factors: 1. as a result of injury during battle, 2. as a punishment for theft, or a part of the process of recording the number of prisoners, or 3. through infection or injury with subsequent intentional surgical amputation. They show a scene from the walls of the Temple of Ramses III near Luxor, Egypt, from circa 1200 B.C.E., and state that this was a scene showing amputation of hands for the counting of prisoners.

We agree with Aldred (5), who believes that this was a process for counting or verifying war dead and not prisoners, since it would be illogical to capture prisoners and then render them unfit for work.

Sussman (69) states that in the Jerusalem Talmud (70) traumatic amputation of the hand in a child is reported. Surgical amputation of the hand as a life-saving method after injury was also known.

Brothwell and Møller-Christensen (14) indicate that removal of hands and feet was certainly being practiced by the time of the Saxons, as indicated by the evidence of a British skeleton. During the Middle Ages, amputation of major parts was performed for leprosy, ergotism, and severe infection. With the introduction of the cannon after 1346, war injuries produced many patients requiring amputation.

Haj states that the second most common cause of amputation among the Arabs between the 7th and 13th centuries in the Middle East was warfare. He says that only the victorious side had surviving amputees since all of the vanquished were slain. Most surviving war amputees were wounded by flying missiles, such as stones and arrows which had been fired from a distance. Those wounded at close range were almost invariably dispatched by the enemy immediately.

Later Primitives

In primitive medicine, diagnosis and therapeutics are inseparable. The diagnostic act is at the same time a therapeutic act. There is no distinction between physical, social, and emotional illness. When the individual is ill, this illness is caused by a god because of the patient's transgression in relation to the society in which he lives.

Tschopik (71) states that the present South American Andean Aymara do not practice amputation.

Johnston (37) states that in Central Africa the natives will rarely submit to even the most minor surgical procedure, and certainly not to amputation even if they will die without the amputation. The reason for this refusal of amputation is that they expect a man's spirit to return in form superior to his present existence, and therefore there is no need

to avoid death by accepting an amputation. Ackerknecht states that this is true for most primitives and that amputation thus is an impressive form of punishment. Amputation for therapeutic purposes would equate them with criminals. This may be the reason there is to date little evidence of amputation in Africa.

There were in Africa, however, the Dama who amputated crippled fingers and toes, according to Vedder in 1923 (73). According to Merker (50), the African Masai amputate limbs with hopelessly complicated fractures with great skill, and have prostheses. They seem to be the only near equals to the ancient Peruvians (55), who appear to have been the best surgeons among the primitives.

According to Weyer (78), Eskimo surgery is crude but effective, demonstrating anatomical knowledge. He quotes Diamond Jenness (35) as stating that the Copper Eskimos amputate frozen extremities. This, Weyer states, is in contrast to the Aztecs, who sacrificed thousands of victims, but who are not known to have performed an anatomical dissection. The Eskimo is accustomed to dissecting animals after hunting them, and thus has a practical knowledge of anatomy. He "knows the positions of joints, muscles, ligaments, veins, and arteries and can find any one of them" (12).

Weyer states that he assisted in amputating two fingers of a boy whose hand had been crushed. This was done without any analgesic or anesthetic. He states that the surgery was no finer than the technique of a reasonably accomplished butcher. Because of the lack of significant danger of infection in the Arctic and strong patient resistance, surgery is generally safe.

Llewellyn and Hoebel (46) describe the case of an Indian who had an arrow in his lower arm until gangrene set in. The Indian who shot him was forced to amputate the arm of the patient with gangrene. He then had to sit with the patient until the stump was healed. Causing a man to have an amputation was considered an extremely serious matter. According to these authors, this was a very unusual situation. They recall a comment by Grinnell (28) who stated categorically that the Cheyennes never practiced amputation: no man was willing to lose a limb, and no doctor would undertake the responsibilities.

Punitive—Juridical

The Ancients

The ancient Peruvians were reported by the Spanish conquerors to have ruled their theocracy with only three laws: 1. do not lie, 2. do not steal, and 3. do not be lazy.

Punishments for infringements of these three laws were severe. In ancient Peru, from 300 B.C.E. on, punishment depended not only upon the crime but also on the social class of the culprit, since it was assumed that

the upper, more educated classes were more responsible for their acts. Theft was severely punished, but if the thief could prove that he stole because he was hungry, he was released and the village chieftain was punished in his stead, since it was the chieftain's duty to assure that no one in his care went hungry. Perhaps we can learn something of value for our civilization from the ancient Peruvians.

Lastres points out that in ancient Peruvian pottery there are many indications of mutilations of the lip, nose, and leg, mostly on the left. Vélez López (74) considers these true mutilations for punishment, especially because of the magnitude of the mutilation which depended upon the magnitude of the fault. Lastres points out that to make a careful diagnosis of lesions from pottery is extremely difficult, since these diagnoses are difficult to make in the living patient, even with modern laboratory and clinical facilities. Lastres states that in his ceramic pieces he found many with the same peculiarity, i.e., amputation in the lower third of the leg, mainly on the left, which he considers punitive mutilation.

Pardal points out that there seem to be two classes of pottery pieces. The first class appears to show mutilations of the nose and lips, and occasionally shows the extremities with a clean cut obtainable only by means of surgical amputation. The representation in ceramic of preparation for the mutilation, and the act itself, along with mention of punitive mutilations in the chronicles of the Spaniards, confirm that these mutilations form the majority of amputations. Another less numerous group appears to show pathological states.

Pardal says there are some written records that discuss the punishment of cutting off the nose and lips of those Peruvian Indians who served in the temples of the Virgins of the Sun.

In Peru at Hualla-Marca and Chancay, amputated feet, apparently from adolescent girls, have been discovered dated from 300 B.C.E. on. Wells states that in an exceptionally elaborate mummy bundle, which contained no other skeletal remains, a foot was found that had been avulsed or torn from the limb. He points out that amputated arms and legs are quite commonly shown in pottery from graves in this region. Amputation in young women destroyed their beauty, and thus might have been punitive for moral transgressions, e.g., adultery or prostitution.

On Huaylas pottery from Peru, amputated arms have been represented as having been tattooed. Figure 11 is from the Moche culture that flourished on the northern coast of Peru from 200 to 1000 C.E. In this figure, the lower extremity is shown well, while the upper extremity ends in short stumps. Note that the clothing conforms to the stump shape, and that the axilla is shown clearly.

Figure 12 illustrates a beautiful Moche IV vase which has painted on its surface a warrior cutting off the left arm of a captured prisoner. Closer examination reveals a number of left arms having been severed. The

FIGURE 11.—Bottle, Moche III, Peru, North Coast, 0–200 C.E., author's private collection.

FIGURE 12.—Bottle, Moche IV, Peru, North Coast, 200–400 C.E., Art Institute of Chicago, Chicago, Ill.

severance seems to be of the guillotine type and is probably below or through the elbow, although other pots show above- or through-the-elbow amputees. Note that the hands are well shown, and that a rope is tied around each wrist. This procedure was undoubtedly a punitive one, possibly for conspiracy to commit theft, or more likely, rebellion. Pris- with alkali to release cocaine, and alcohol were in common use as they are unlikely that they would be mutilated in a manner as to render them unfit to work. Note that the prisoner has ear plugs and a headdress, indicating that he was from the upper class. The prisoner in Figure 12 is alert, indicating that no anesthesia was being used. Coca-leaf chewing with alkali to release cocaine, and alcohol were in common use at it is today, so the lack of anesthesia or analgesia reinforces the conclusion of the punitive nature of the amputation. Some figures show both arms amputated above or through the elbow, which would completely incapacitate an individual.

It has been reported (14) that a number of skeletons dated to the 7th century C.E. were found on Tean in the Scilly Isles, England, in 1956. One is probably a middle-aged male, with a hand and distal 21 mm. of the radius and ulna amputated. There was a synostosis between the radius and ulna. Some slight evidence of reaction to infection 25 mm. proximal to the distal end of the stump was noted. They state that this appeared to have resolved rapidly, since there was not too much perio-

steal reaction. There were some osteophytes at the stump margins, especially on the volar side.

The length of the patient's left tibia was 361 mm., while on the right it was only 312 mm. The cadaver appeared to have had a foot and part of the lower leg amputated. The ends of the bones were well healed and rounded, and a synostosis between the tibia and fibula was present. There was osteoporosis, presumably due to disuse, in other bones of the right lower extremity. They speculate that the loss of the leg probably occurred not too long before death, since the osteoporosis was not too severe. While they do not say so, it is probable that these amputations were not done prior to the end of growth. The growth discrepancy is not great, which it would have been in the case of a congenital or early childhood amputation. They felt that the mutilations were probably not made by a saw, such as they found in association with a Danish skeleton, but were probably the result of intentional removal by means of an axe (see Fig. 12) or a heavy knife hammered with a mallet, which, they pointed out, are methods known to have been employed as punishment in Britain during the Dark Ages. They quote Pike's *A History of Crime in England,* which states that offenders were branded on the forehead and were punished by amputation of the hands, feet, and tongues, to live as an example of the danger which attended the commission of crimes.

Many kings passed laws ruling that criminals should have a hand or foot removed for punishment, which would not kill the criminal but deform him so that the law-breakers would act as visual deterrents to others. This form of mutilation lasted in Europe at least into the 17th century. This type of mutilation severely restricted the working ability of such a person and begging was undoubtedly the most suitable profession (Fig. 13).

The authors (14) present other alternatives to punitive mutilations:

1. The removal of extremities in armed combat. They state that, in their opinion, in most cases the levels would be different, and other results of trauma should be seen.

2. Surgical removal after severe injury. This is possible, but in many cases the number of amputations in one individual would seem to preclude multiple injuries in a primitive society without machines (Fig. 14).

3. Amputation for severe frostbite. This is possible, provided the lesions are essentially symmetrical.

4. Surgical amputation for some chronic debilitating mutilating disease. This appears to be unlikely in most instances from examination of the amputees' healthy appearance.

Haj states that in the Arabic Middle East the most common cause of amputation by far was juridical. Islamic jurisprudence gave theologic sanction to corporal punishment, which was very severe prior to Mohammed. Mohammed personally ordered amputation as punishment for sev-

FIGURE 13.—Bottle, Moche III, Peru, North Coast, 0–200 C.E., Larco Herrera Museum, Lima, Peru, photographed at Solomon R. Guggenheim Museum, New York, N.Y.

FIGURE 14.—Bottle, Moche III, Peru, North Coast, 0–200 C.E., National Museum of Anthropology and Archaeology, Pueblo Libre, Peru.

eral people. Amputation was used additionally to disqualify individuals from high religious or political life, out of religious hostility, for moral disapproval, to intimidate or take vengeance on enemies, for political expedience, and for other reasons. Haj states that the Koran explicitly requires amputation for robbery as was the custom for centuries before Mohammed, and since. The Koran unequivocally states "if a man or woman steals, cut off 'their' hand in retribution for that which they committed."

Later Primitives

Packard (53) and Lawson (44) stated that partial-foot amputation was used by the Iroquois and Seneca Indians when they took a captive and wanted him to work in the fields. The Indian captive was thus hindered from making his escape, since he could not run rapidly and since his footprints were characteristic.

According to Hilton-Simpson in 1913 (33), the Arabs and Shawia considered death preferable to the loss of a limb. Punishment by bodily mutilation in such tribes is damaging far beyond the physical disability it leaves, since it isolates a man from society and makes him a pariah.

Amputating the hands of thieves is still carried out among certain peoples, such as the Bedouin, today. Until recent times, many instances are

recorded of the practice in more advanced countries. The most common practice is to place the hand or hands on a block. The person performing the punitive amputation does so by means of a large, sharp sword by striking one blow at or near the articulation of the wrist (see Gillis).

Gillis states that the Negroes in the Congo and the Brazilian Indians frequently had their hands amputated at the wrist by the overseers, in the last century, if they collected insufficient wild rubber. He states that bleeding was not excessive.

Conclusions

To me, there is ample evidence to support the fact that multiple causes of amputation existed, as they do today. For example, Gillis reports that in the Far East, beggars amputate one or both of their feet after progressively strangling them to become gangrenous, and then use the mummified feet as a means of obtaining charity.

While frostbite has been considered as a reason for amputation in Europe and among the Eskimos, it seems to have been neglected for Peru. We consider it possible, since amputations of the feet are often necessary in individuals who have been exposed to prolonged cold while intoxicated. One would expect multiple amputations of the distal parts of the limbs, nose, and ears. The lips would rarely be involved. No clear-cut example of Peruvian pottery showing this combination is known to the author.

Accidental amputations of the lower extremities would occur at any level. The fairly consistent level of amputation at the ankle is shown by the bulbous end of the cleft between the tibia and fibula, which seems to indicate punitive, rather than traumatic or medical, amputation (see Fig. 14).

To us, there appear to be Peruvian figures which fall into each of three classes: 1. pots showing mutilations of the nose and/or lips, undoubtedly caused by disease; 2. pots in which there is some doubt as to whether the deformities illustrated are caused by disease or by surgical intervention; and 3. pots clearly showing surgical destruction of the nose and other members, probably for punishment, but possibly for curative or religious reasons. The incision line is sharp and clear. A few figures show destruction of the nose, lips, and one or both feet. Some authorities have claimed that the multiple amputations are the result of mucocutaneous leishmaniasis. We doubt this because, while leishmaniasis does indeed destroy the nose and lips, it rarely causes a major amputation. More importantly, in leishmaniasis the first thing to be destroyed in the nose is the septum. A careful look at the figures reveals that invariably the septum of the nose is portrayed very clearly (Fig. 7, 8, 9, and 14). It is our contention that the amputations of the lips, nose, and feet were done as punishment and were not due to disease in most instances. We specu-

late that amputation of the lips was possibly the punishment for lying, while amputation of the foot could have been punishment for either theft or laziness. Others contend that the parts amputated were chosen to cure the destructive effects of leishmaniasis or syphilis. Some figures are extant which appear to fall into each category.

SURGICAL TECHNIQUES

Level

The Ancients

All levels of amputations were performed except shoulder or hip disarticulations, to our knowledge. Punitive amputation by primitive people tends to take the form of disarticulation of joints, since incisions through muscle bellies cause a great deal of blood loss. Haj states that wrist amputation was usual, but that at least one case is known to him of bilateral elbow amputations for theft. Multiple amputations were done for people who continued to steal, as was ordered by Mohammed himself. Ligatures, cautery, and sutures were known in some cultures.

Ankle disarticulations were common (Fig. 15). Certainly Peruvian Moche figures (see Fig. 14) from 200 to 900 C.E. illustrate a line of sep-

FIGURE 15.—Effigy figure, Moche III, Peru, North Coast, 0–200 C.E., Peabody Museum, Harvard University, Cambridge, Mass.

FIGURE 16.—Figurine, Chancay, Peru, Central Coast, 900–1530 C.E., Larco Herrera Museum, Lima, Peru, photographed at the Solomon R. Guggenheim Museum, New York, N.Y.

aration which was quite clear, and which probably was meant to represent the cleft between the tibia and the fibula.

An example of wrist disarticulation is the Chancay (300 B.C.E. to 1440 C.E.) effigy from the central coast of Peru (Fig. 16) in which one sees a man sitting with crossed legs and playing a form of panpipe with his right hand. His left hand has been amputated, apparently at the wrist.

The pre-Columbian Peruvians had many objects in the form of separate parts of the body. They show club feet, normal feet in sandals, etc. (Fig. 17). Some appear to have been used as vessels, while others appear to be votive objects. There is one object which is a stirrup-spout bottle (Fig. 18) which appears to be not a votive object but rather to demonstrate an amputated leg. The leg clearly was amputated above the knee, as the sectioned femur is shown raised and light, while the surrounding representation of flesh is below the bone level and colored red. This appears to be evidence that above-knee amputation was known. We have not seen any pots from Peru unequivocally showing a patient with an above-knee amputation. Larco Hoyle (41) states that he saw a pot showing bilateral above-knee amputation in the Vicus style.

Later Primitives

Lawson describes transmetatarsal amputation among the American Iroquois and Seneca Indians in 1714. There is one stone figure of a seated woman from the Tumlin Mound, Bartow County, Georgia (Fig. 19), which shows bilateral absence of the lower extremities above the knees. The legs are not folded under the skirt. This might represent artistic license.

Sigerist (64) states that according to Gurlt (30) in 1894 the natives of Tumale in Central Africa, performed amputations with great skill. The patient was given an alcoholic beverage until he was practically unconscious. Skin and muscles were cut through, and the bare bone was placed on a block. It was then cut through with a hatchet. The hemorrhage was controlled by having the parts cauterized with hot butter or a red-hot stone. After this, the stump was tightly dressed. Sigerist points out that the source was a dissertation written in 1845 by a man who had never been to Africa, who was reporting what had been told to him by a Negro whom a Bavarian prince had brought to Munich. Sigerist states that surgical amputations were performed occasionally by primitives but he thought that this was done rarely. The Masai, the best primitive surgeons, did amputations in emergencies (see Merker). Johnston (36) states that punitive mutilations, including the cutting off of a hand or foot, were fairly frequent, but he did not consider them as surgery. Since the amputation was to punish the individual and not to kill him, disarticulation is the most logical.

FIGURE 17.—Votive object, Chimu, Peru, Lambayeque Valley, 1000–1440 C.E., Museum of the American Indian—Heye Foundation, New York, N.Y.

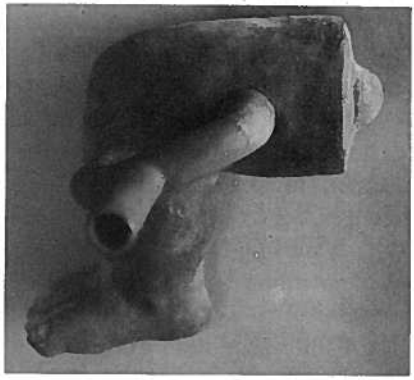

FIGURE 18.—Bottle, Moche III, Peru, Ancon, 0–200 C.E., Museum of the American Indian—Heye Foundation, New York, N.Y.

FIGURE 19.—Stone figure of seated woman, Tumlin Mound, Bartow County, Ga. (Photograph courtesy of the Museum of the American Indian—Heye Foundation, New York, N.Y.)

Anesthesia and Methods

The Ancients

In early amputations, speed was of the essence to diminish bleeding and pain. Anesthetics were in rare use in Europe except for the use of alcohol. Some concoctions of opium were in use. This was despite the fact that

the Talmud tells us that anesthetics, both local and general, were employed in major operations. Various drugs were used to lessen pain and to induce sleep.

Haj states that anesthesia was not widely used until about the 10th century C.E. Cautery was used earlier.

The ancient Peruvians intoxicated themselves with cocaine from coca leaves or alcohol.

Gillis (p. 1) states that some archaeologists think that surgical amputation has probably been performed since Neolithic times. He states that human Neolithic skeletons have what appear to be amputated bony stumps. Since they also had stone knives and saws, he suggests that this theory may be correct. Saws have been known for at least 6000 years. Natural jawbone was used but more commonly pieces of flint or obsidian were set into wood to mimic a natural jawbone. Many examples of this were found in the Middle East, Switzerland, and in both North and South America.

With the advent of metals, saws of copper and then of bronze, and of iron were fashioned. Certainly, by the time of the Romans, saws were quite sophisticated. Holländer is said to have performed amputations in 6 or 7 minutes with Neolithic saws of stone and bone. He experimented with reconstructed Neolithic saws for amputation and trepanation (16).

Wells states that at Obermenzing in Bavaria, Germany (21), and at Kiskoszeg, Hungary, doctors' graves of the La Tene (Iron Age) period have been found. These graves contained snares, retractors, and amputation saws.

Celsus (53 B.C.E. to 7 C.E.) described the use of a flap technique in amputation and ligatures to control hemorrhage. He said that the flesh should be cut with a scalpel to the bone, but this should not be done over a joint; that part of the healthy tissue should be cut and no diseased tissue should be left behind; that the bone be cut with a saw after elevating the soft tissues; that the bone be divided at a level higher than the soft tissues; that the bone be smooth; and that subsequently the skin should be drawn over the bone as completely as possible.

Larco Hoyle states that the Peruvian Moche after 200 C.E. did amputations, cutting off feet, legs (see also Moodie, 51), arms, lips, nose, and male genitalia. In amputating arms and legs, he says they took great care and precision, cutting the bone at a level higher than the flesh incision in order to leave a healed stump.

An anthropomorphic whistle found in the Chiriqui region of Panama shows the motif of an amputation above the knee. Coury states that the amputation was made with an obsidian saw and a rasp.

Gillis (p. 1) quotes Albucasis, a Muslim surgeon (1013–1106 C.E.), who wrote towards the end of the 11th century: "When gangrene of the lower arms or legs does not yield to medication, one should amputate to

prevent it extending above the elbow or knee before it becomes fatal. The limb should be slightly bound above and below the line of severance, while an assistant pulls upwards on the upper bandage to retract the skin and flesh. One should make a circular incision down to the bone, insert linen pads on both sides to prevent ulceration, then cut or saw through the bone. If hemorrhage occurs during the operation, cauterize promptly or apply some hemostatic powder before proceeding, apply a suitable dressing and tend until cured."

Later Primitives

Hieronimus Brunschwig of Strassburg (born 1497 C.E.) is stated (26, 47) to have confined his practice to the care of traumatic wounds including amputation. In performing amputations, he used soporifics and applied boiling oil or cautery to check hemorrhage from the stump. The first known European illustration of an amputation was in *Feldtbuch der Wundartzney* by Hans von Gerssdorff (76), published in 1517. The illustration is of a below-knee amputation being done with a saw over a basin to catch the blood. The patient was obviously unconscious and showed no pain. The patient may have been given one of the medications containing opium to cause sleep. Von Gerssdorff mentioned a soporific drink and gave its formula, but stated, "I have never used it or seen it, and still I have cut off one hundred or two limbs at St. Anthony's Court in Strassburg and elsewhere."

Lawson in 1714 stated that the Seneca and Iroquois Indians denuded the skin from the base of the toes to the middle of the foot, cut off half of the foot, and then wrapped the skin over the wound and sutured the skin to the sole, of war captives. Tutschek (72) states African Tumale do amputations after intoxicating the patient.

Densmore (23) relates the story of Main-Gans whose limbs were amputated below the knee. The only instrument used was the common knife. When this Chippewa Indian was a boy, his feet and legs were badly frozen and useless. The pain was so intense that he begged a man to amputate them. The man did so. The wounds were dressed with pounded bark, applied dry, and renewed as often as it became damp, usually twice a day. Nothing else was used and the healing was perfect.

Wezawange, an Indian, states that gangrenous flesh was removed with a knife after the flesh had been loosened by using the inner bark of white pine, wild plum, and wild cherry trees. The barks were boiled together until they were soft (23).

Control of Hemorrhage

The Ancients

While some historians doubt the use of the ligature, the evidence appears strong that it was used by the South American Indian by 1500

B.C.E. Compression, astringents, bandaging, tourniquets, and the cautery were all known. Garrison states that the ancient Hindus did not practice arterial ligation.

Ligatures were probably used by the ancient Peruvians. They used knots in their weaving, in their fish and bird nets, and for recording numbers. Knotting a ligature around an artery seems probable. No writing existed, and no Peruvian mummy has been found with a definite amputation, so that we have no direct evidence of the use of ligatures.

In Europe, after the fall of the Roman Empire, surgical amputation techniques became much more crude. The ligature was forgotten and bandaging by using body parts of animals or the actual cautery with boiling pitch were used (11). This is the identical technique described for Indian postamputation care.

Another means of controlling postamputation bleeding could have been by tongs which are similar to our present forceps. We know that they were used for picking up soft or small objects at least as early as 3200 B.C.E. The use of compression either by instruments or the fingers to compress blood vessels to stop bleeding would permit amputation with subsequent survival.

Gillis said that by 800–400 B.C.E. in Austria, forceps with a ring to keep the points together to maintain compression were in use. The ring, used to pull the points together, may have been employed until healing occurred, but more probably was used while the ligature was being tied. Gillis points out that Heister (32) showed the original collar-stud catch with a central slot and ring, invented about 550 B.C.E., and its relationship to two artery forceps used in his time.

Patients can survive transection and avulsion of a limb without fatal hemorrhage. Cheselden in 1756 (19) described and illustrated a case in which a miller had an avulsion of his right arm at the forequarter level. Cheselden noted that there was very little bleeding, because the arteries were stretched. The patient had no severe symptoms and was cured by superficial dressings only. It appears that, under certain conditions, traumatic amputation of even a major degree may occur without having a patient bleed to death, irrespective of whether ligatures are used. Major blood vessels and muscles can be compressed until bleeding stops. Katholitzky (38) reported in 1873 the case of a 37-year-old mason who, when working, had the entire right upper extremity avulsed, including the scapula. There was little bleeding immediately or subsequently in spite of the fact that the blood vessels have not been tied. At surgery, the skin edges were merely brought together, and no secondary or primary hemorrhage occurred. By the 25th day, the patient walked out of the hospital. This illustrates again that patients can survive traumatic and surgical lesions of major blood vessels without necessarily having a fatal hemorrhage.

While speculation as to the use of ligatures and cautery for prevention of hemorrhage after surgical amputation of the extremities is of interest, amputations of the extremities may well have been done without the patients bleeding to death, without treatment for the blood vessels, or merely with compression to bleeding areas. The fact that ligatures were unknown in the culture is, to some extent, irrelevant in determining whether amputations were performed in that culture.

In 1517, von Gerssdorff described techniques of military surgery, which included the use of a pressure bandage without sutures and a caustic plaster. Pressure of the hands was used predominantly but if this failed, a hot-iron cautery or boiling oil was used. He also used ligation of bleeding vessels, a tourniquet, or styptic chemicals and then covered the stump with a pig or beef bladder (26). Scultetus in 1655 (63) described amputation of the hand by a single blow of a chisel and mallet, and then bandaging of the extremity. This was generally done at the wrist. The technique used was the Peruvian technique. He also illustrated the use of boiling oil and hot-iron cautery. Haj described the Arabic technique and states that the caliphs and others ordered anyone handy to do the amputation, irrespective of whether he had any knowledge of medicine or surgery. Ambroise Paré appears to have reintroduced the ligature in 1552 (56).

Many Indian tribes controlled hemorrhage even though they lacked knowledge of the ligature. Most tribes knew the action of a cautery on bleeding vessels. The Mescaleros packed oozing wounds with the down of eagles or scrapings from the inside of freshly tanned hides. The Missouri River tribes used puffballs or smooth sumac to pack wounds. Almost all the American Indian tribes understood the use of the tourniquet.

Among the Senecas and Iroquois, hemorrhage (see Lawson) was stopped by ligatures of sinew. Stone (67) says that these were the only tribes to understand the use of the ligature. Packard agrees.

Merker pointed out that the Masai were the only African tribe known to suture blood vessels with tendons. Their surgery was much better than that of all primitive tribes and all European peoples up to the Renaissance.

Skin Closure

The Ancients

Figure 15 shows an ankle disarticulation. Figure 20 shows an ankle disarticulation that is different. In this figure, the distal end of the stump is painted much darker than the rest of the skin of the stump. This should be compared with the other figures illustrated previously. This poses the question of whether the skin was closed after amputation, or whether the wound was left open to granulate. Some authors (18, 54, 55, 64, 68) claim that the skin was sutured not with thread but with the use of large tropi-

cal ants or termites in African Somali, Brazil, and India. It is claimed that it was a custom in those cultures to stimulate the ants to clamp their jaws in such a way that one jaw would hold each skin margin. The thorax of the ant or termite was then cut from the head. The insect thus served as an involuntary suture material. While the dispute of whether this was actually done has not been resolved, Dr. Dieter Jetter of the Department of Medical History at the University of Heidelberg informs the author that they have tried the procedure with tropical ants and that it has succeeded. Irrespective of this, it appears that some wounds were probably left open to granulate.

It is also worth noting that the Peruvians were expert weavers, and it may well have been that they used cotton skin sutures. Certainly, gauze and cotton were known (3). Figure 20 may demonstrate one in which the suture line disrupted for some reason.

FIGURE 20.—Bottle, Moche III, Peru, North Coast, 0–200 C.E. (Photograph courtesy of Paleopathology Museum, Dos de Mayo Hospital, Lima, Peru.)

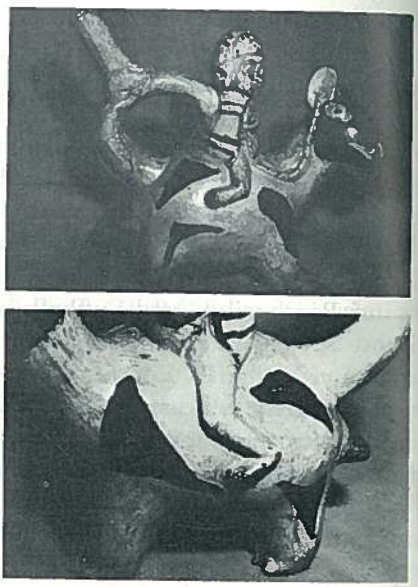

FIGURE 21.—Figurine, Moche II, Peru, North Coast, 50–0 B.C.E., private collection, Lima, Peru.

Guerra (29) states that the Aztecs (900–1500 C.E.) treated nasal wounds with sutures. When the nose amputation left a cosmetic defect, a prosthesis, made of some convenient material, was recommended after the wound had healed. Sutures were frequently made of thorns placed into each side of the wound and then held together by string. This was occasionally covered by liquid latex (25).

Figure 21 is a fascinating figure from Lima, Peru, and is in the Moche-Chimu style. It shows that amputees survived and were able to work. The exact age of this piece is unknown but it shows a boy riding on an animal. Horses were unknown to the Peruvians before the arrival of the Spaniards and thus this probably represents a boy riding on a llama, since a llama cannot carry a fully grown man. The split hoof of the animal shows that it is not a horse but a cameloid. Examination of the figure reveals that the distal end of the stump is discolored as in Figure 20. To illustrate that the absence of the foot on one side was intentional and not accidental, the reverse side of the same figure shows a perfectly normal knee, ankle, and foot with toes. Thus, there is no question that the artist wished us to know that his foot was disarticulated at the ankle.

Later Primitives

Wounds were sutured by many American Indian tribes. The Dakota, Carrier, Mescalero, Winnebago, and Tuscarora tribes used threads of sinew on bone needles to suture larger wounds (52, 53, 62, 67). They removed the sutures in 6 to 8 days. They insisted that all wounds must heal from the bottom out by granulation. They accomplished this, even when using sutures, by placing a thin membrane of the bark of a tree between the cut surface of the tissues before suturing the wound. Some Indians, such as the Mescaleros, used pieces of cloth or fiber as wicks to promote drainage. Human hair was also used as a suture material by some American Indian tribes (4).

Lindblom (45) stated in 1920 that the African Akamba suture wounds using thorns. If a wound is fresh and clean, the edges of the wound are approximated and thin acacia thorns are put through the edges on each side. The thorns are placed in pairs, one across from each other. The thorns are tied with a cord which maintains the skin approximation. Thorns were used for sutures also among the Masai in Africa (50).

PROSTHESES

Lower-limb prostheses are crucial for function, and so were developed early as an outgrowth of crutch use. Pezei (58) informs us that Herodotus narrated the story of a soothsayer made prisoner by the Spartans and placed in irons, who cut away his foot through the ankle joint with a knife in order to be able to escape. Afterwards, he is stated to have made himself a prosthesis of wood for the amputated foot. He quotes the evidence of an Italian vase of the 4th century B.C.E., in which one sees a lame man walking with a rod. He calls attention to the mosaic of the Cathedral of Lescar in which a Negro man is shown with a wooden pylon instead of his right foot. The pylon is similar to that which is in use today. Pezei further points to the archaeological evidence of a leg in bronze, iron, and wood, which was found during the excavations in

Capua, Italy, in 1858 in a tomb dated to the 3rd century B.C.E. (77).

Pazzini (57) tells of a prehistoric Italian vase illustrating a faun missing a leg, replaced by a prosthesis, which appears to be a hood around the cylindrical stump. The joint appears to rest directly in the socket. A Hellenic vase of unknown date appears to be similar. It illustrates an amputee with a "peg-leg" prosthesis. From the figure, it is hard to determine whether this is a knee-disarticulation or an above-knee prosthesis. The "socket" seems to be a posterior splint held on by a cord or rod.

At about 300 B.C.E., prostheses made of two tubular bones of a ram were used in Russian Kazakhstan (TASS, Jan. 23, 1971).

In both the Jerusalem and the Babylonian Talmuds, it is clear that, at that time, surgical amputations were done and amputees were supplied with artificial limbs. In addition, the Talmud mentions a "peg leg" given to an amputee and says that padding should be put into the concave top of the wooden pylon to provide some relief for the stump. The patient was also given leather knee pads to protect his extremities while walking on the ground. These are still in use today where "conventional" prostheses are too expensive for poor people.

Larco Hoyle and Vélez López mention certain Peruvian pottery pieces that show prosthetic devices made from pieces of wood. According to Pardal, one Peruvian mummy has been studied that represents a disarticulation of the foot. The patient had a wooden pylon on the lower extremity for walking.

Figure 22 illustrates a Peruvian Moche man, blind in one eye, putting a prosthesis on an ankle-disarticulation stump. Close examination reveals that this prosthesis is irregular. It is not known whether this is a poor artistic representation, common in later Moche figures, or whether it is intended to present a cloth-like padding. The problem with ankle disarticulations is that the sharp lower edges of the malleoli of the tibia and fibula are painful on weight-bearing.

Figure 23 is in the Moche style and illustrates clearly an alert individual who is ready to place a rigid bowl-like prosthesis over his ankle-disarticulation stump. The bones are clearly delineated and the distal end of the stump is bulbous. Undoubtedly, this prosthesis had some soft padding of cloth to reduce pain.

Pardal states that Dr. Lizardo R. Lopez communicated to the Congress of Americanists in London in 1912 that he had observed a Peruvian prosthetic appliance, which consisted of a wooden pylon, on a mummy that showed a disarticulation of the foot. The bones of the foot were applied to the pylon and the part that was worn away on the pylon was the inferior part which rested on the floor. He concluded from this that it was probably used for walking. This corroborates the evidence of the pots which show the prostheses.

Jerome Bosch lived about the time of Columbus' discoveries (1450–

FIGURE 22.—Bottle, Moche III, Peru, North Coast, 0–200 C.E., American Museum of Natural History, New York, N.Y.

FIGURE 23.—Moche II, Peru, North Coast, 50–0 B.C.E., American Museum of Natural History, New York, N.Y.

1516 C.E.). This Dutch artist drew a number of figures in which he illustrated amputees with prostheses and crutches.

Peter Breughel, the Elder, of Holland also painted some amputees with example of prostheses used in his time, 1525–1569 C.E. Figure 24 shows a classic Jalisco figure from Mexico (300–900 C.E.) with above-knee "stubby" prostheses and short "crutches" identical to the crutches illustrated by Breughel 1000 years later. This is the only such figure to exist.

Upper-limb prostheses were rarely used in ancient times. Occasional rare cosmetic hands are known to have been used by the rich. Figures showing upper-extremity amputations are not shown with patients wearing prostheses. An Egyptian cosmetic hand was found on a mummy dated from 2000 B.C.E. It had a forearm socket which was close-fitting and was made of fiber. During the Second Punic War, 218–201 B.C.E., a Roman general, Marcus Sergius, lost his right hand and had it replaced by a metal artificial hand. Pezei says that Pliny records that the great-grandfather of Catalina, Sergio, wore an iron hand after having the hand injured in war. Pezei also describes a prosthesis from the 15th century similar to that used by Count Goetz von Berlichingen in 1501, and somewhat similar to that designed later by Ambroise Paré. Von Berlichingen had a hand with movable fingers which could be extended and flexed to

FIGURE 24.—Effigy figure, Jalisco, classic, Mexico, 300–900 C.E., author's private collection.

hold a sword, but it was so heavy that it had to be attached to his suit of armor. The fingers and wrist were moved passively.

In 1564, Paré developed the first known above-elbow prosthesis incorporating a locking elbow and a leather cosmetic hand. After his publications, a number of rich amputees with above-elbow amputations had prostheses made of metal with movable digits.

CONCLUSION

It is my hope that this short trip through the early history of amputation will make readers aware that many of the techniques used in amputation and in prosethetic fitting are not new, and that many of the solutions that have appeared to be brilliant flashes of insight are in fact rediscoveries of or derivations from what has been known for centuries.

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